SIZE- AND SEX-DEPENDENT SOCIAL INTERACTIONS OF THE LESSER BANDICOOT RAT, *BANDICOTA BENGALENSIS*[1]

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(*With five plates*)

Experiments were carried out on the behavioural interaction of equal and unequal sized male-male, male-female and female-female pairs of *Bandicota bengalensis* in neutral cages. The elements of behaviour have been briefly described and are classified into non-social, amicable, agonistic and sexual behaviour. The results show that adult *B. bengalensis* are highly intolerant, with females as aggressive as males. One male was always dominant over the other. Male-male aggression was higher compared to other two pairs. Amicability and increasing body weight showed an inverse relationship. Larger males and females dominated smaller ones.

INTRODUCTION

The lesser bandicoot rat, *Bandicota bengalensis* has been considered as a field or rural rat (Ellerman 1961), causing heavy damage to grain in cultivated fields (Roy 1974) and warehouses (Spillett 1968). However, since 1900 it has become a major component of urban rodent population in India (Deoras 1963, Spillett 1968) and Burma (Harrison 1949). The high inter- and intra-species aggressive activity of this species is considered as the major cause for its successful urban invasion (Spillett 1968). Collias (1944) also regards intra-species strife as one of the stimulants for species spread to new geographic regions. Since information available on the intra-species interactions of *B. bengalensis* is scanty (Spillett 1968, Frantz 1973, Sridhara, Narasimhan and Krishnamoorthy 1980), this paper records the behavioral components of *B. bengalensis* in detail as observed during paired encounters in neutral cages. Attempts are also made to measure the influence of sex and size of the partner on amicable and agonistic behaviour.

MATERIALS AND METHODS

The rats were caught by digging out burrows in paddy (*Oryza sativa*) fields around Bangalore. At the laboratory, they were acclimatised for a fortnight by maintaining them in galvanised iron mesh cages (35 × 35 × 50 cm), with a nest box (10 × 12 × 19 cm) on one side containing cotton for bedding. They were fed on rat and mouse feed (Hindustan Lever, India). Water was supplied ad libitum. Lighting regime was 12 h light (1800-0600 h) and 12 h darkness (0600-1800 h). Room temperature varied at 23 ± 4°C.

Encounters between different pairs were staged in a 100 x 50 x 50 cm observation chamber. It had a galvanised sheet back, glass sides and front, and wire mesh top. A sliding

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partition made of galvanised sheet divided the chamber into two equal parts. The glass sides were also of sliding type facilitating easy introduction of animals.

All interactions were studied between 1000 h and 1200 h to avoid diurnal fluctuations of activity. For each encounter, two animals were placed on either side of the partition and left for five minutes to allow them to settle down. The partition was then slowly removed and the ensuing encounter observed for 10 minutes and their behaviour noted down.

The first set of experiments was designed to study the effect of size on the amicable and agonistic behaviour of equal sized male-male, male-female and female-female pairs. Four weight regimes in the increasing order under each category of pairs were observed (Table 1), with four replications being carried out under each size.

TABLE 1

SEX COMBINATIONS STUDIED AND THEIR WEIGHTS

	Equal sized pairs				Unequal sized pairs			
I	Male-1	vs	Male-2	I	larger male	vs	smaller male	Weight diff.
	150 ± 1.1		150 ± 0.92		258 ± 1.05		208 ± 0.76	50
	170 ± 1.03		170 ± 0.85		250 ± 0.58		180 ± 0.81	70
	200 ± 0.83		200 ± 1.46		260 ± 1.53		170 ± 1.24	90
	260 ± 1.83		260 ± 1.31		245 ± 0.94		145 ± 0.86	100
II	Male	vs	Female	II	larger male	vs	smaller female	Weight diff.
	100 ± 1.04		100 ± 0.79		170 ± 1.21		140 ± 0.88	30
	150 ± 1.2		150 ± 1.18		194 ± 0.95		134 ± 1.14	60
	170 ± 0.87		170 ± 0.91		214 ± 1.83		114 ± 1.16	100
	200 ± 0.73		200 ± 1.34		266 ± 2.05		160 ± 0.93	106
III	Female-1	vs	Female-2	III	smaller male	vs	larger female	Weight diff.
	100 ± 0.67		100 ± 1.22		170 ± 0.84		190 ± 1.81	20
	140 ± 1.21		140 ± 1.33		154 ± 1.06		204 ± 0.93	50
	170 ± 1.05		170 ± 0.91		105 ± 0.95		205 ± 0.81	100
	200 ± 0.76		200 ± 1.33		100 ± 1.02		260 ± 0.95	160
				IV	larger female	vs	smaller female	Weight diff.
					214 ± 2.33		184 ± 1.41	30
					190 ± 1.85		130 ± 1.14	60
					186 ± 1.63		106 ± 1.25	80
					206 ± 0.88		106 ± 1.26	100

Figures represent weight in g ± S.E.

In the second set of experiments the effect of increasing weight difference between the pair members on behaviour was studied. Four types of pairs were used, namely larger male *versus* smaller male, larger male *versus* smaller female, smaller male *versus* larger female and larger female *versus* smaller female; four replications were tried under each type.

A total of 168 animals (84 males and 84

non-pregnant females) in the weight range of 100-266 g were utilized. No attempt was made to determine the estrous conditions of the experimental females.

Based on the descriptions of Grant & Mackintosh (1963), Ewer (1971), Barnett (1975) and Begg & Nelson (1977), the various 'Postures' (Static position, Grant & Mackintosh 1963) and 'acts' (behaviour involving movement, Grant & Mackintosh 1963) of *B. bengalensis* behaviour were identified; whenever deviations occurred, descriptions were given. Of the whole range of behaviour elements only the frequency of occurrence of amicable behaviour (Nosing, allogrooming and huddling) and agonistic behaviour (Threat, crawling over/under, lunge, chase, attack, fight, boxing, bite, submissive posture and flight were considered for statistical comparisons between the sexes and sizes.

The mean and standard error of amicable and agonistic behaviour counts were computed. To assign amicable/agonistic status to either of the sex, student 't' test was conducted. For establishing influence of size on the behaviour Spearman-rank correlation tests were conducted assigning ranks to weights and behaviour scores from which rs was computed (Siegel 1956). Kruskal-Wallis one way analysis of variance was carried out to establish amicable and agonistic order of the three sex combinations studied (Siegel 1956).

RESULTS

BEHAVIOURAL COMPONENTS AND THEIR CLASSIFICATION

Non-social behaviour. Exploring involved walking, running, jumping, climbing, scratching, digging, sniffing, handling and gnawing objects. These acts help to perceive the sensory input from the surroundings.

Grooming consisted of several acts which help in cleaning the body surface. These included scratching, licking, wiping, nibbling, combing the body surface and face (plate I, 1).

Amicable behaviour. Approach is any directed movement towards another animal (Begg & Nelson 1977).

Nose-nose while approaching each other, two rats touch each other's nose and sniff, with the body in *stretched attention posture* (Plate I, 2).

Nosing is touching the fur or body surface of the opponent with the nose.

Ano-genital sniffing. The ano-genital region of one rat (mostly female) is sniffed by another rat, a male in majority of the cases.

Huddling. Crouching of two rats with their bodies in close contact. The behaviour, though well established for laboratory and feral Norway rats, *Rattus rattus* (Barnett 1958), and *Rattus villosissimus* (Begg & Nelson 1977), was not seen in paired encounters of *B. bengalensis.*

Allogrooming is grooming or nibbling the fur or combing with the forepaws of one rat by another.

Agonistic behaviour: *Approach.* If the two rats were of equal social status, the animals moved towards each other with body fully extended, held low to the ground; tail remained stiff and horizontally raised. Eyes and ears were focussed on the opponent (Plate I, 2). Plate II, 3 and 4 demonstrate the approach act of a dominant rat towards a subordinate.

Displacement activities are those acts which seem to have no relevance to the behavioural situation in which they take place. These include *displacement grooming* which consists of wiping the face with forepaws. During *displacement digging* the ground is scratched or any material or object is pushed with the help of legs. Often rats *mark* the cage floor with the whole or part of the ventral body surface. Of these only displacement grooming and marking were displayed by *B. bengalensis.*

Push-past. The act involved the dominant animal pushing between the wall of the cage and a crouching submissive rat.

Crawling under. A submissive rat crawls slowly beneath the body of its aggressive opponent with its dorsal surface in contact with the latter's ventral side. Crawling under may be between fore- and hindlimbs or just beneath the other rat's head. Such complete act of crawling under was not seen in *R. villosissimus* (Begg & Nelson 1977), instead crawling under consisted of resting one rat's head below the other's head or abdomen. A similar posture was displayed by *B. bengalensis* (Plate III, 5).

Crawling over: The approaching rat typically walks over the head/dorsal surface of another rat. Both *R. villosissimus* and *B. bengalensis* restrict the act only to placing the head over another rat's head or dorsal surface (Begg & Nelson 1977) (Plate III, 6).

Piloerection is raising body hairs erect and indicates the social status of confronting rats. If the two rats are equally matched, both exhibit piloerection (Plate III, 6), but in unequally matched pairs, it is displayed only by the dominant rat (Plate II, 3; Plate III, 5; Plate IV, 7, 8; Plate V, 9, 10).

Offensive sideways posture. To start with, all the four feet of the dominant rat will be on the ground freely extended. The body is arched accompanied by piloerection. The subordinate rat will be usually crouched in a corner of the cage (Plate III, 5). The aggressive rat moves side ways, pushing the submissive to a corner of the cage (Plate IV, 7).

Defensive sideways posture. The defending rat usually crouches in a corner of the cage. It tries to prevent the attack with its forelimbs. Its head will be twisted towards the attacker (Plate IV, 7).

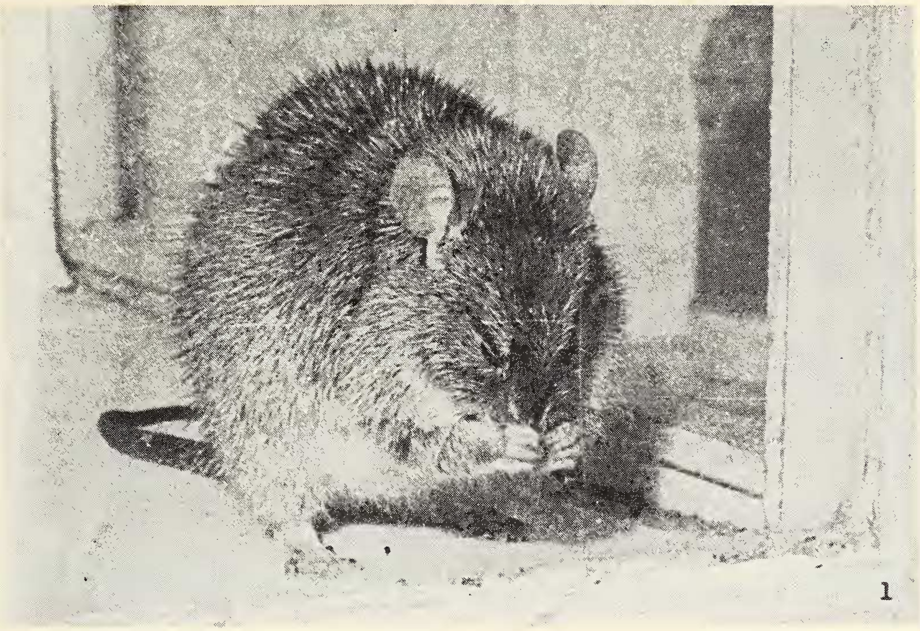
Offensive and defensive upright posture. Normally both the rats assumed this posture simultaneously, standing erect on hindlimbs and tail, presenting the ventral side to each other. They may remain still with forepaws touching or hold the forepaws of each other resulting in the 'Boxing' posture (Plate V, 10).

Fleeing is running and escaping from the opponent.

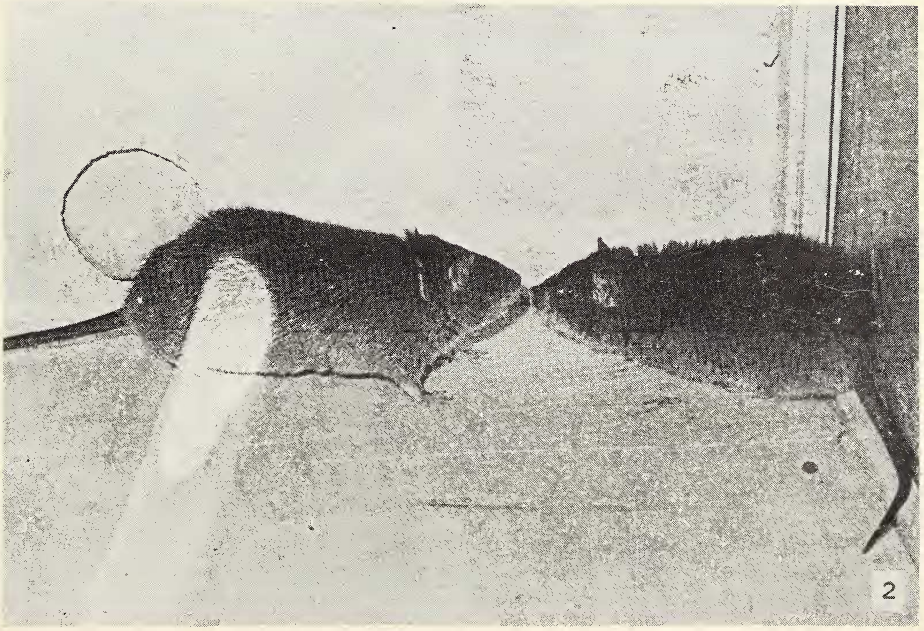
Chasing is running after the fleeing rat.

Leap. Often the more aggressive rat leaps on another rat prior to exhibiting the *Offensive sideways posture* or while chasing the fleeing rat (Plate V, 9).

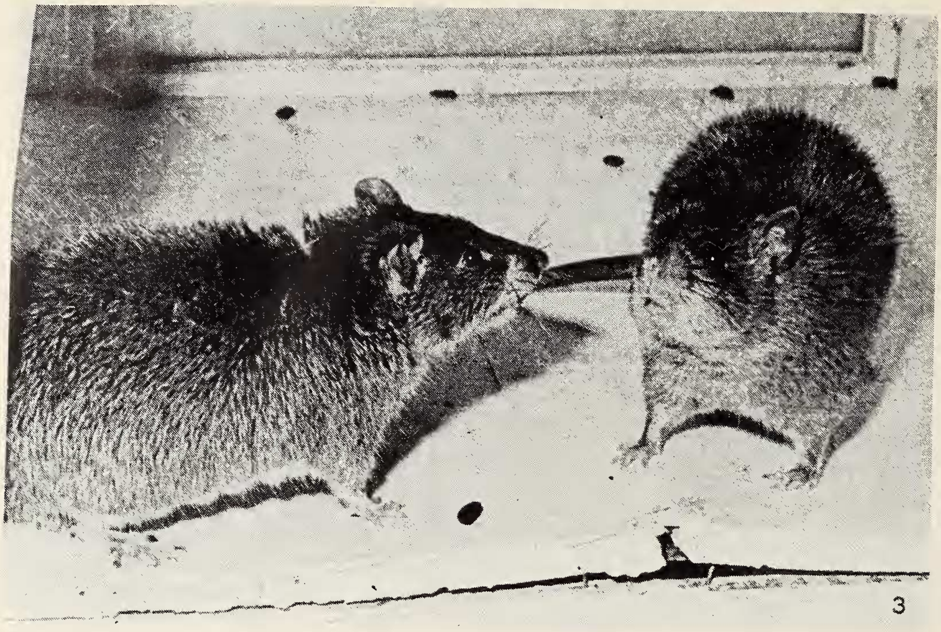
Submissive posture. The term seems to involve slightly different descriptions. Rather different species of rodents seem to display slightly varied postures, the aim being to prevent attack by the dominant conspecific. The act consists of lying down on the side with eyes closed, usually displayed during approach by a dominant rat (Barnett 1975). In contrast Begg & Nelson (1977) describe that an animal facing a severe attack, suddenly lies on its side or back with all the four limbs in the air with eyes closed. The head may be twisted towards the attacker and mouth open. Squealing accompanies this act. In the woodmouse, *Apodemus sylvaticus*, the animal is on its hindlimbs, head lifted, ears held back, eyes half closed and the forepaws are tucked in (Gurnell 1977). The submissive posture of *B. bengalensis* seems to closely resemble this. The rat stands on its hindlimbs



Grooming.



Approach by two equal status rats.
(*Photos*: S.H. Sridhara)



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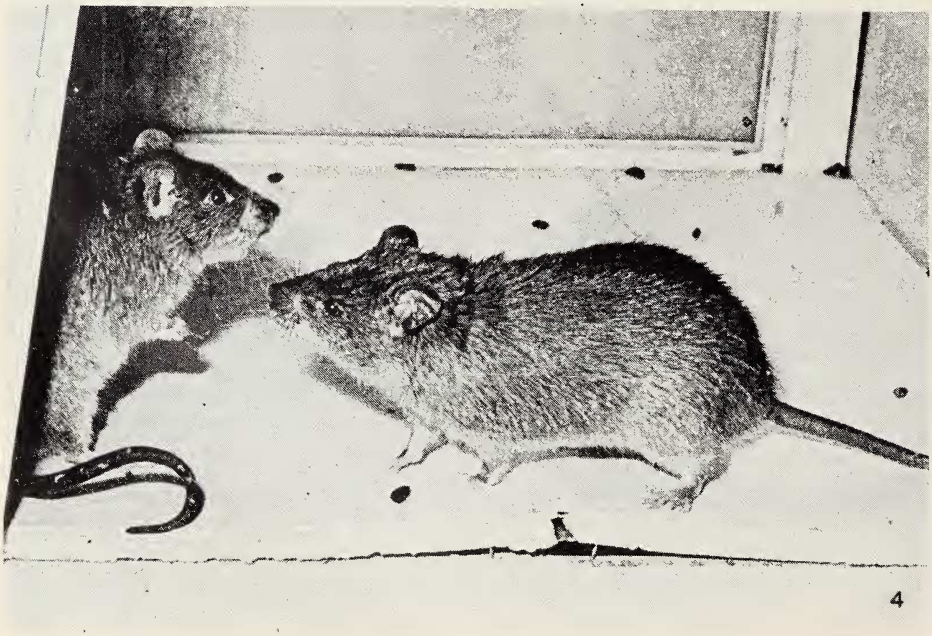
Approach by submissive rat on left, *offensive sideways* posture on right.



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Defensive upright posture on left, approach by dominant on right.
(*Photos*: S.H. Sridhara)

with forelimbs withdrawn but eyes are kept open (Plate IV, 8). The posture is accompanied by squealing. The act helped to ward off attack both during approach of the dominant rat and in the middle of a fight.

Crouching. The animal bends its back, draws up the body holding it low, usually in a corner of the cage.

Sexual activities. Beach's (1966) description of sexual activities encompasses acts like following: *Attempted mount, mount, intromission, ejaculation, post-copulatory groom* and *lordosis.* Ano-genital sniffing can also be included under this. *B. bengalensis* in cages exhibited only following: *Ano-genital sniffing* and *attempted mount.*

Temporal sequence of activity. The sequential occurrence of responses during intraspecies encounter of *R. villosissimus* were broadly divided into three arbitrary phases which graded into each other (Begg & Nelson 1977). The behaviour of *B. bengalensis* in paired encounters closely resembles these phases, which can be briefly described thus:

Phase 1. The initial 2-3 minutes of an encounter were characterised by highest agonistic behaviour and the establishment of dominant-subordinate relationships. In equally matched male pairs cautious approach by the two males was the first act. This was followed by nose-nose, sniffing each other or offensive sideways/offensive upright posture by both or sudden leap, attack boxing, fleeing and chasing. The boxing posture was displayed for 30-40 seconds, then one of the rats broke off, assumed a submissive posture and started squealing. In unequal male pairs, at the approach of the dominant rat itself the subordinate assumed a submissive posture accompanied by squealing. The dominant rat displayed offensive sideways posture or attacked the submissive animal. In male-female encounters similar sequence of activities took place but fights were mostly preceded by ano-genital sniffing by both sexes more often by the male. Female tended to attack the male whenever the latter tried to sniff her genital region or tried to mount her. In female-female interactions initial approach and fighting took place for a very short duration, i.e. within a minute.

Phase 2. The offensive and defensive acts and postures continued but at a relatively low intensity in male and male-female confrontation. Displacement activities were exhibited by both dominant and submissive rats.

Phase 3. There was more or less complete cessation of agonistic behaviour. Non-aggressive acts like crouching by the subordinate in a corner, exploring by the dominant initially, later by the submissive and grooming by both occurred.

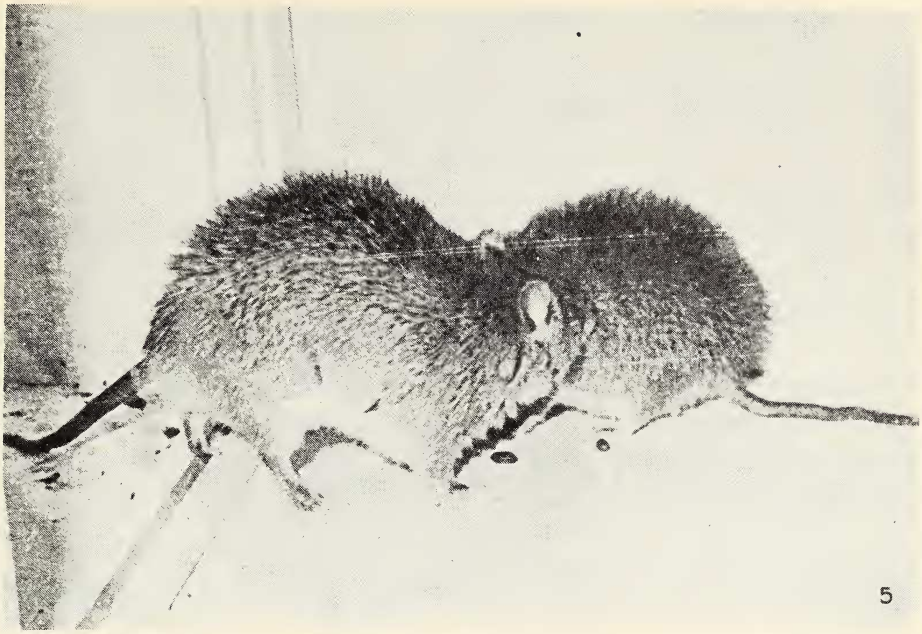
Influence of sex on amicable and agonistic behaviour. Amicable behaviour was seen in equal measures in male-male and male-female encounters and was least in female-female interactions ($H = 5.41$, $P < 0.049$, Kruskal-Wallis one way analysis of variance), implying more contact behaviour in the two former pairs. Male-male confrontations were characterised by highest agonistic behaviour followed by male-female and female-female interactions ($H=11.31$, $P < 0.008$, Kruskal-Wallis one way analysis of variance).

Influence of size on amicable behaviour. In equal sized male-male interactions, one male was more amicable ($P < 0.02$ and 0.001; Table 2) whereas in female-female and male-female encounters of same size category both were equally amicable except at 100 g weight level where one of the females in the former case and the female in the latter case exhibited more amicability ($P < 0.001$, Table 2: $P < 0.02$, Table 3). Amicable behaviour

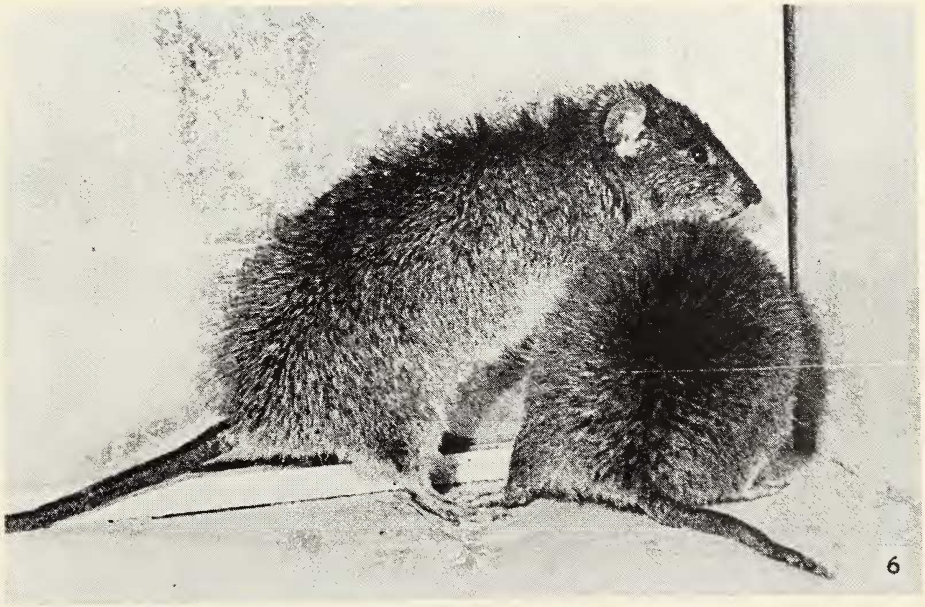
TABLE 2

AMICABLE AND AGONISTIC BEHAVIOUR SCORES OF MALE-MALE AND MALE-FEMALE PAIRS OF *B. bengalensis*

Sex of the pair	Counts of	Equal sized pairs			Unequal sized pairs		
		male/female	male/female	P <	larger/larger male/female	smaller/smaller male/female	P <
I Male vs Male	Amicable behaviour	2.00±0.75	23.62±2.62	0.001	1.33±0.27	8.67±0.72	0.001
		4.33±1.09	13.66±2.59	0.02	0.67±0.15	9.33±1.96	0.02
		3.66±0.72	9.33±0.72	0.001	1.33±0.27	10.67±0.72	0.001
		2.66±0.27	8.33±1.44	0.02	2.67±0.27	17.33±1.91	0.001
	Agonistic behaviour	2.00±0.82	—	0.05	11.66±1.51	3.33±0.54	0.01
		13.00±0.47	15.00±1.67	0.05	43.33±4.57	21.67±2.12	0.02
		10.67±1.78	34.00±2.49	0.001	42.66±2.23	17.33±1.44	0.001
		21.00±0.67	25.00±0.82	0.02	10.33±0.72	3.67±0.54	0.001
II Female vs Female	Amicable behaviour	28.00±1.63	8.00±1.41	0.001	1.00±0.47	4.00±0.47	0.05
		16.00±2.62	8.00±1.63	0.05	—	2.00±0.94	0.05
		9.33±1.44	9.67±1.44	0.05	2.00±0.47	12.00±1.41	0.001
		2.33±0.54	1.67±0.54	0.05	2.33±0.27	16.67±1.94	0.001
	Agonistic behaviour	2.33±0.27	7.67±1.48	0.02	36.00±2.35	9.00±0.94	0.001
		5.33±0.98	11.67±1.19	0.02	36.33±3.14	7.67±1.19	0.001
		4.33±1.91	6.67±1.96	0.05	17.33±0.98	5.66±0.98	0.001
		2.00±3.27	4.00±2.24	0.05	5.00±0.94	—	0.01

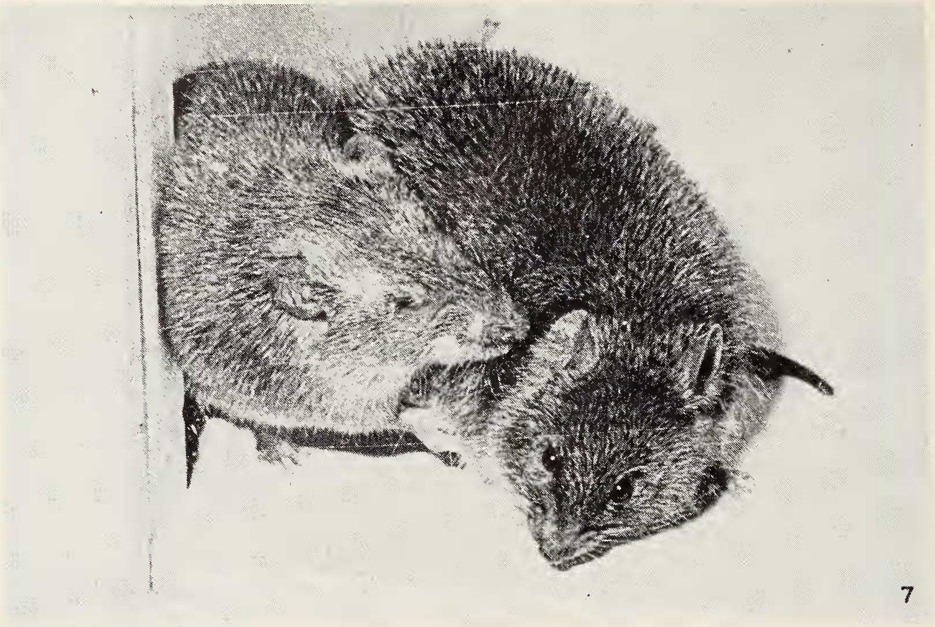


Crawling under by the right rat (submissive).



Crawling over by the left rat (dominant rat).
(*Photos*: S.H. Sridhara)

PLATE IV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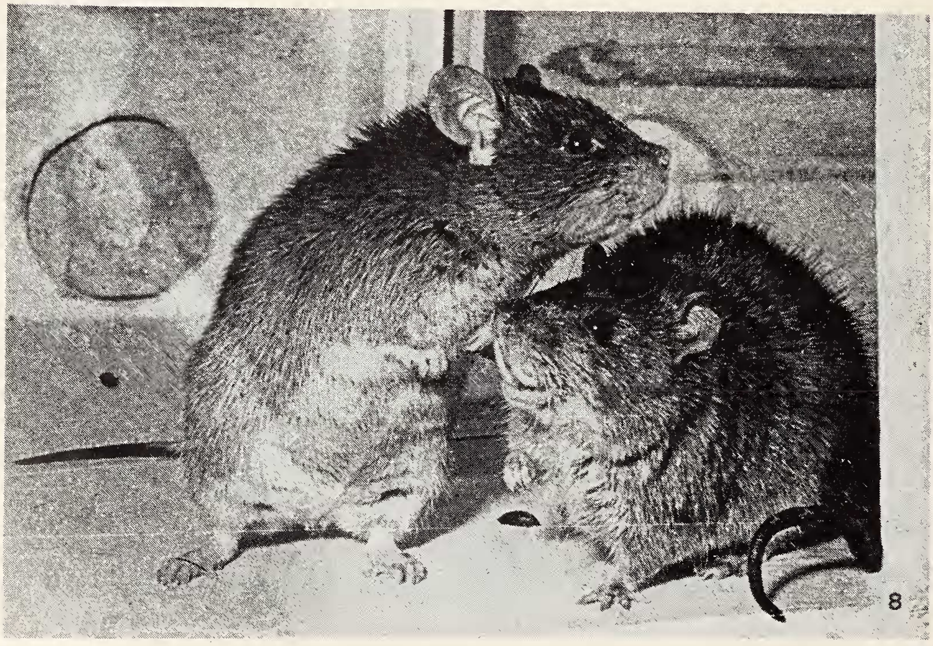
Defensive sideway posture on left, *offensive sideway posture* on right.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Submissive posture on left, approach by dominant on right.
(*Photos*: S.H. Sridhara)